

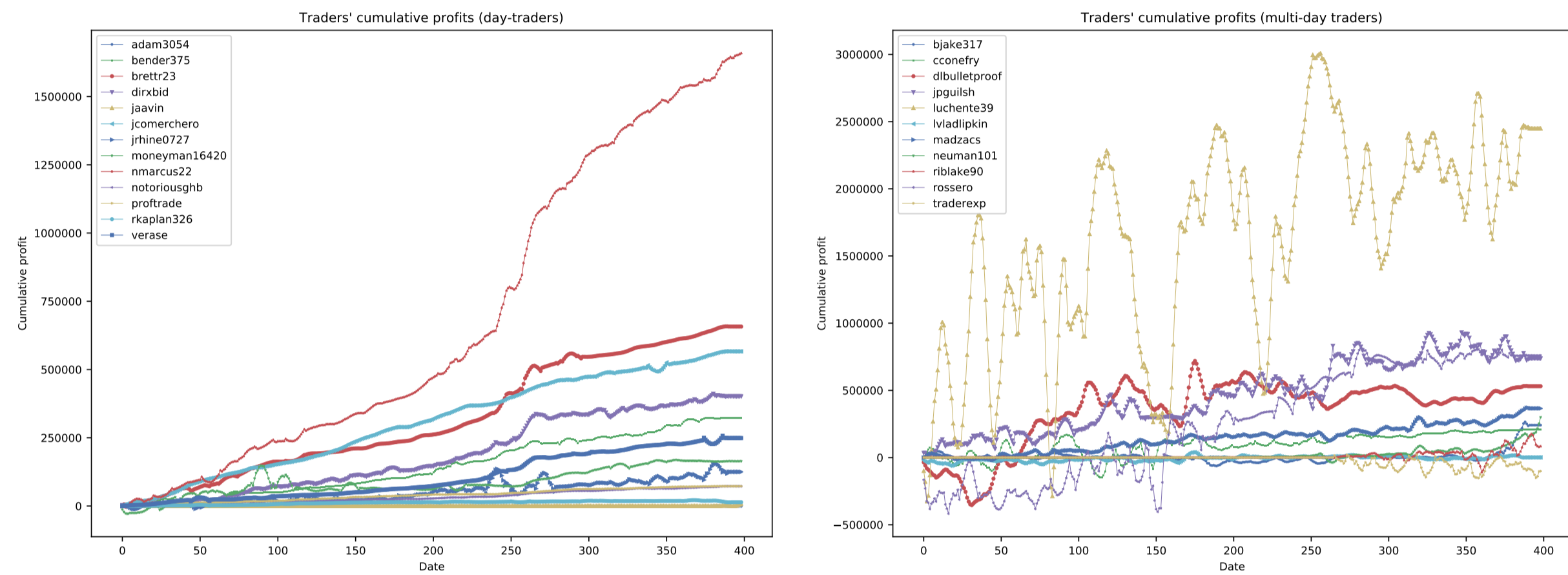
# Performance-driven Collaboration Among Stock Traders

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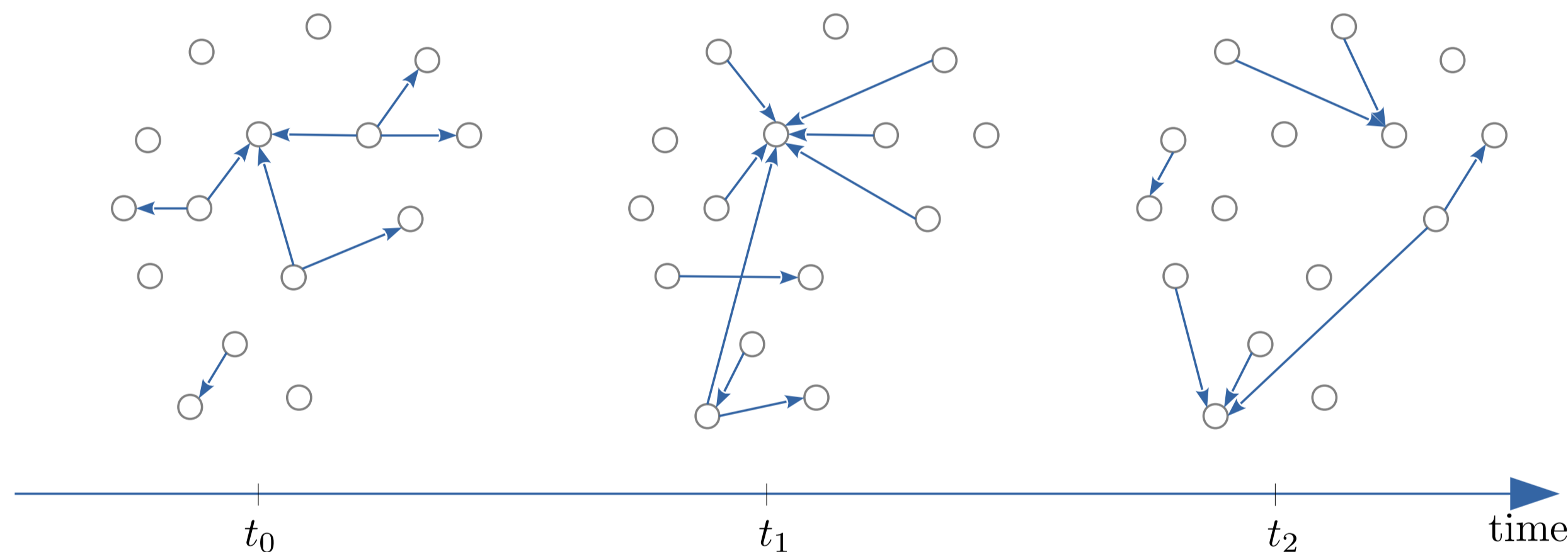


## Setting

- A group of stock traders engaged into two processes:
  - making profit via stock trading



- communicating with each other



- We have a collaboration network with dynamic links and node values.

## Problem

- Known:** Collaboration facilitates performance.
- Hypothesis:** Performance drives collaboration.
  - Global reputation: traders' performance is globally observed.
  - Local reputation: traders have a history of collaboration with perceived value.
  - Traders form collaboration alliances based on their peers' observed global and local reputation.
  - Focus on causation, rather than just correlation.
- Goal:** Design a model that ties together performance and collaboration, and empirically validate it together with the Hypothesis.

## Observations From Data

- High-performers collaborate more.

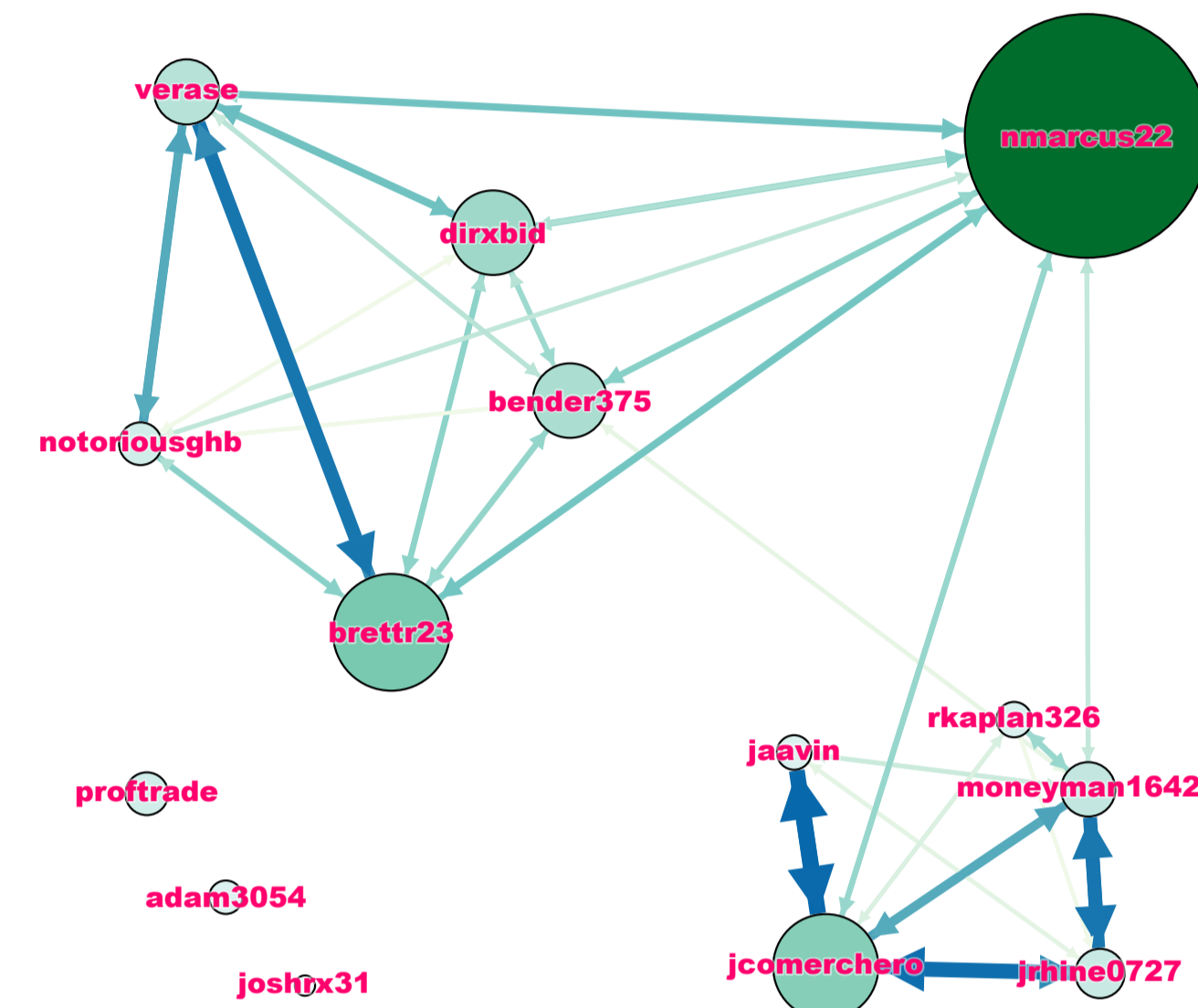


Figure: Trader collaboration network. Edge weights reflect the number of days each pair of traders collaborated over the entire multi-year trading period.

- Collaboration is constrained by trader similarity.

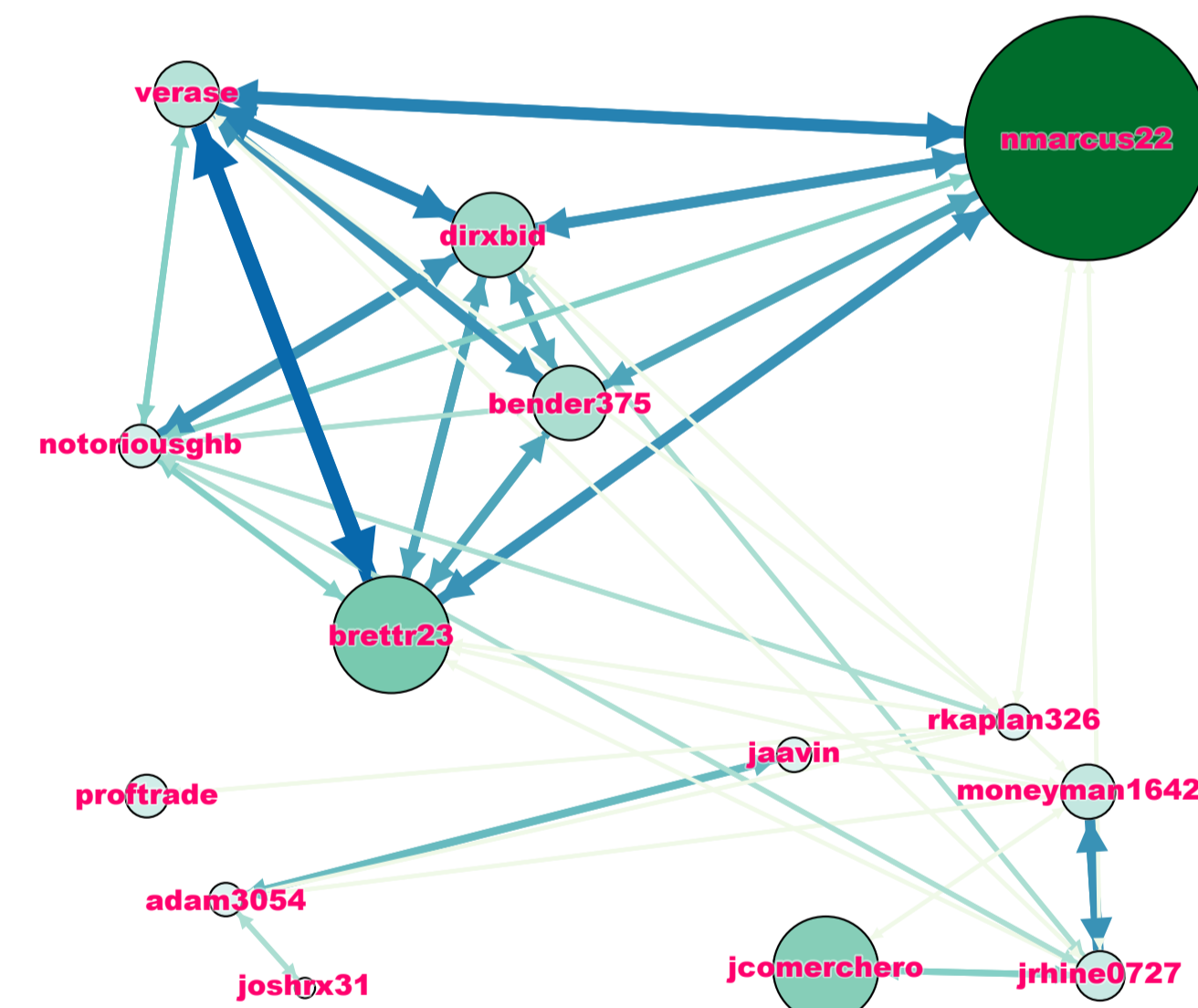


Figure: Trader similarity network. Edge weights reflect the proportion of the top-15 most frequently traded stocks two traders have in common.

- For ~half of the traders, performance Granger-causes collaboration.

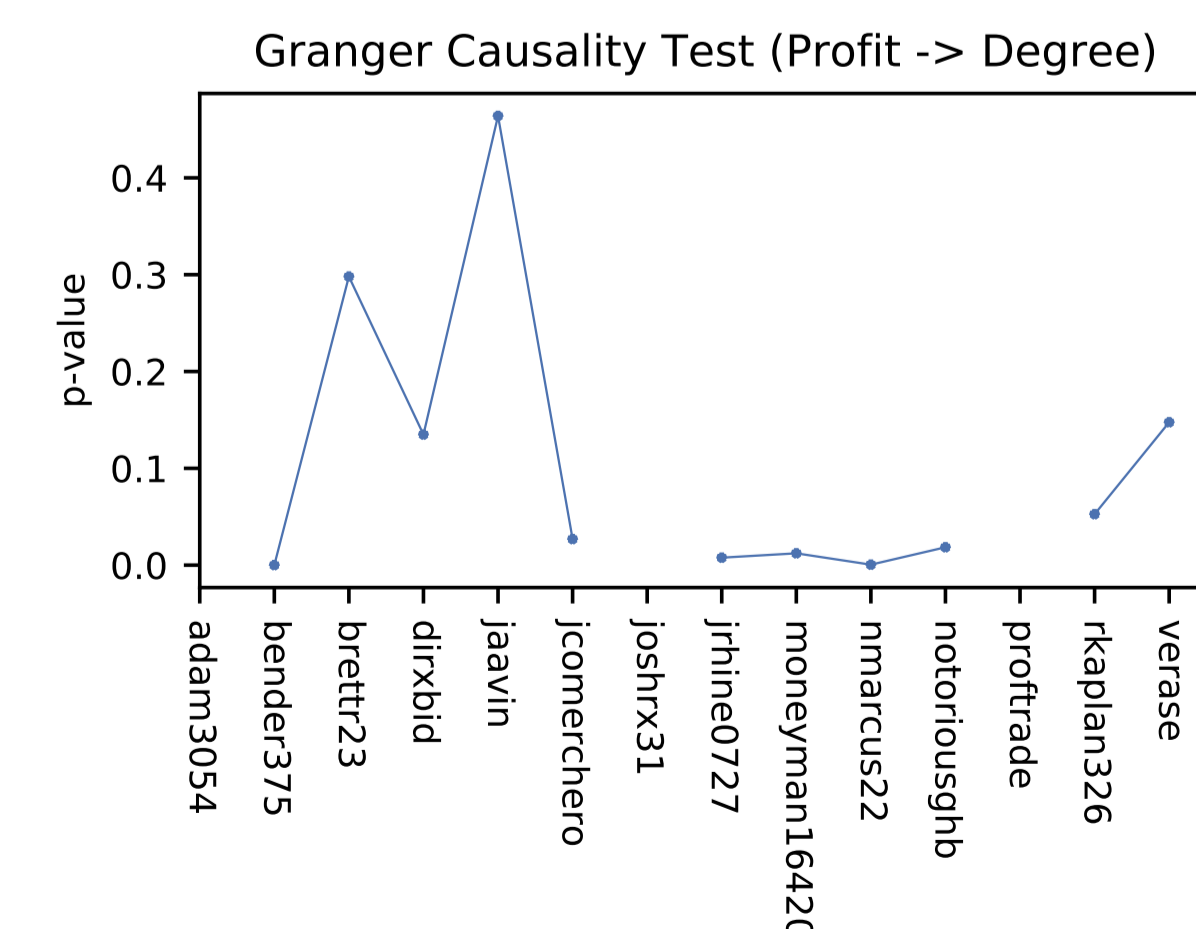


Figure: Granger causality test for the effect of traders' cumulative profits upon their degrees in the (summarized) collaboration network.

## Theoretical Model

- Observed variables:
  - $p(t) \in \mathbb{R}^n$  – agents' profits at the end of day  $t$ .
  - $s(t) \in \mathbb{R}_+^n$  – observed profit-making capabilities;  $s(t) = \frac{1}{t-1} \sum_{\tau=1}^{t-1} p(\tau)$ .
  - $C(t) \in \{0, 1\}^{n \times n}$  – agent collaboration structure at time  $t$ .
  - $W(t) \in \mathbb{R}^{n \times n}$  – observed value of collaboration prior to day  $t$  (made profit is associated with the edges  $C(t)$  active during the corresponding days).

$$W(t) = \frac{1}{t-1} \sum_{\tau=1}^{t-1} \text{diag}([\text{collab. profit}] (\tau)) C(\tau), \quad W(1) = \epsilon \mathbb{1} \mathbb{1}^T.$$

- Locally observed variables:
  - $\phi = \text{const} \in \mathbb{R}^n$  – true capabilities of the agents to make profit.
- Hidden variables:
  - $e(t) \in \mathbb{R}$  – the "environment"'s profit-generating capability.
  - $\Theta = \text{const} \in \mathbb{R}^{n \times n}$  – true value of collaboration.
- Agent's utility: knowing  $s(t)$  and  $W_{i*}(t)$ , and assuming collaboration structure  $C_{i*}(t)$  and  $C_{*i}(t)$ , on day  $t$ , agent  $i$ 's utility  $u_i(e(t), s(t), W_{i*}(t), C_{i*}(t))$  is

$$u_i(\dots) = \underbrace{\alpha_1 \phi_i}_{\text{inherent prof.}} + \alpha_2 e(t) + \underbrace{\langle \beta_1 W_{i*}(t)^T + \beta_2 s(t) \rangle}_{\text{acquired proficiency}} - \underbrace{\gamma \mathbb{1}}_{\text{collab. overhead}}, C_{i*}(t)$$

- Rational behavior:  $\hat{C}_{i*}(t) = \arg \max_{C_{i*}(t)} u_i(0, s(t), W_{i*}(t), C_{i*}(t))$
- Actual profit:  $p_i(t) = u_i(e(t), \phi, \Theta_{i*}, \hat{C}_{i*}(t))$
- System's performance in  $t$  days:  $\langle s(t), \frac{\mathbb{1}}{t} \rangle$

## Ongoing Work

- Analysis of (non-summarized in time) dynamics of collaboration.
- Relation of traders' performance to stock price changes and text content.
- Inference trading strategies.
- Development and analysis of theoretical model, and its empirical validation.